

1822

29

An
Inaugural Dissertation
on the Formation of
Bone.
and the
Physiology of the Skeleton.
By
William S. C. Baum,
Pennsylvania.

1823.

Published March 25th 1823

1881

1.

An Inaugural Dissertation on the formation of Bone, and the Physiology of the Skeleton.

The object of the following Essay is to present a consistent view of the Formation of bone, and physiology of the ~~formation~~ of the skeleton, and more particularly to notice the views which have been recently suggested by professor Physick in relation to this subject.

That a knowledge of the structure, actions and functions of a part are an essential requisite to a surgeon, is incoucitable: without this knowledge, his practice must be confined to the narrow limits of observation alone, and being ignorant of those operations which it is his business to effect, much uncertainty and even puerility must necessarily follow.

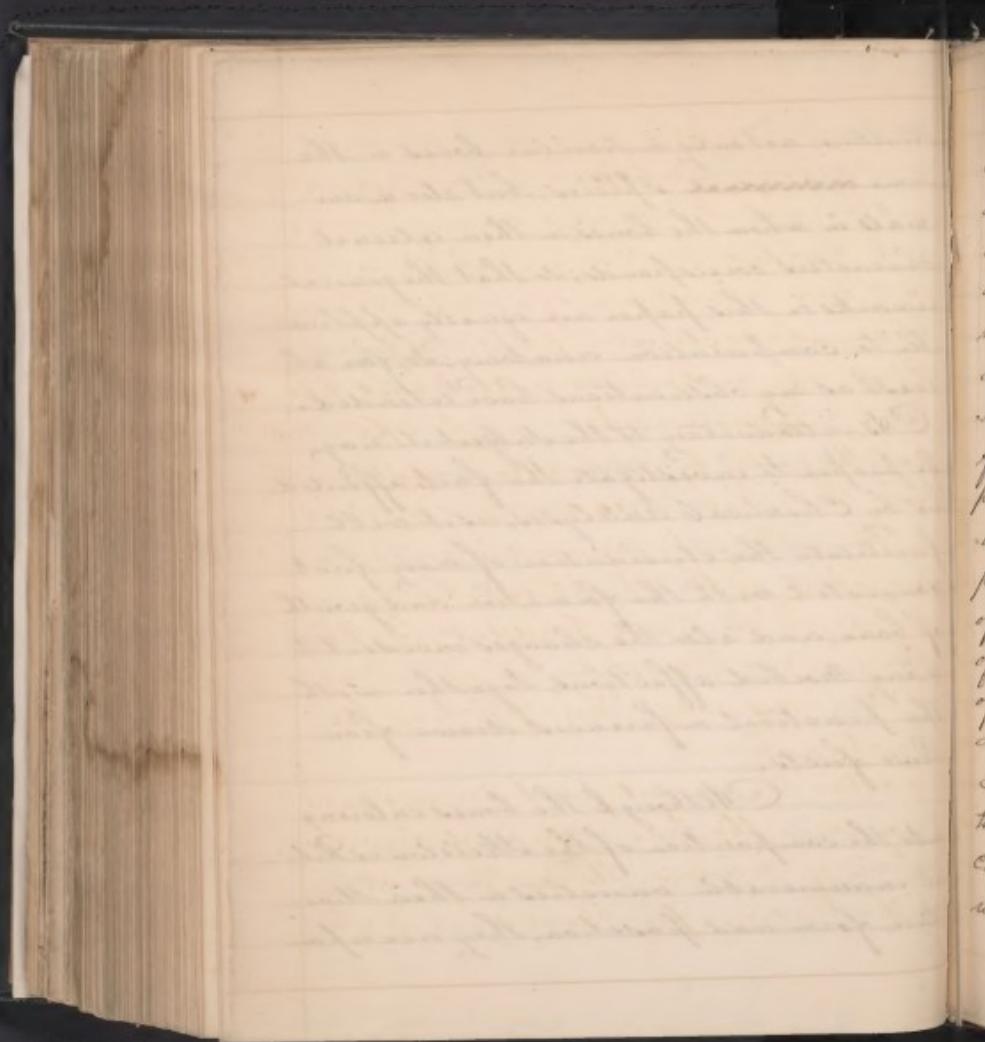
There appears to exist an uniformity of

2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60
61
62
63
64
65
66
67
68
69
70
71
72
73
74
75
76
77
78
79
80
81
82
83
84
85
86
87
88
89
90
91
92
93
94
95
96
97
98
99
100
101
102
103
104
105
106
107
108
109
110
111
112
113
114
115
116
117
118
119
120
121
122
123
124
125
126
127
128
129
130
131
132
133
134
135
136
137
138
139
140
141
142
143
144
145
146
147
148
149
150
151
152
153
154
155
156
157
158
159
160
161
162
163
164
165
166
167
168
169
170
171
172
173
174
175
176
177
178
179
180
181
182
183
184
185
186
187
188
189
190
191
192
193
194
195
196
197
198
199
200
201
202
203
204
205
206
207
208
209
210
211
212
213
214
215
216
217
218
219
220
221
222
223
224
225
226
227
228
229
230
231
232
233
234
235
236
237
238
239
240
241
242
243
244
245
246
247
248
249
250
251
252
253
254
255
256
257
258
259
260
261
262
263
264
265
266
267
268
269
270
271
272
273
274
275
276
277
278
279
280
281
282
283
284
285
286
287
288
289
290
291
292
293
294
295
296
297
298
299
300
301
302
303
304
305
306
307
308
309
310
311
312
313
314
315
316
317
318
319
320
321
322
323
324
325
326
327
328
329
330
331
332
333
334
335
336
337
338
339
340
341
342
343
344
345
346
347
348
349
350
351
352
353
354
355
356
357
358
359
360
361
362
363
364
365
366
367
368
369
370
371
372
373
374
375
376
377
378
379
380
381
382
383
384
385
386
387
388
389
390
391
392
393
394
395
396
397
398
399
400
401
402
403
404
405
406
407
408
409
410
411
412
413
414
415
416
417
418
419
420
421
422
423
424
425
426
427
428
429
430
431
432
433
434
435
436
437
438
439
440
441
442
443
444
445
446
447
448
449
450
451
452
453
454
455
456
457
458
459
460
461
462
463
464
465
466
467
468
469
470
471
472
473
474
475
476
477
478
479
480
481
482
483
484
485
486
487
488
489
490
491
492
493
494
495
496
497
498
499
500
501
502
503
504
505
506
507
508
509
510
511
512
513
514
515
516
517
518
519
520
521
522
523
524
525
526
527
528
529
530
531
532
533
534
535
536
537
538
539
540
541
542
543
544
545
546
547
548
549
550
551
552
553
554
555
556
557
558
559
550
551
552
553
554
555
556
557
558
559
560
561
562
563
564
565
566
567
568
569
570
571
572
573
574
575
576
577
578
579
580
581
582
583
584
585
586
587
588
589
590
591
592
593
594
595
596
597
598
599
600
601
602
603
604
605
606
607
608
609
610
611
612
613
614
615
616
617
618
619
620
621
622
623
624
625
626
627
628
629
630
631
632
633
634
635
636
637
638
639
640
641
642
643
644
645
646
647
648
649
650
651
652
653
654
655
656
657
658
659
660
661
662
663
664
665
666
667
668
669
660
661
662
663
664
665
666
667
668
669
670
671
672
673
674
675
676
677
678
679
680
681
682
683
684
685
686
687
688
689
690
691
692
693
694
695
696
697
698
699
700
701
702
703
704
705
706
707
708
709
700
701
702
703
704
705
706
707
708
709
710
711
712
713
714
715
716
717
718
719
720
721
722
723
724
725
726
727
728
729
720
721
722
723
724
725
726
727
728
729
730
731
732
733
734
735
736
737
738
739
730
731
732
733
734
735
736
737
738
739
740
741
742
743
744
745
746
747
748
749
740
741
742
743
744
745
746
747
748
749
750
751
752
753
754
755
756
757
758
759
750
751
752
753
754
755
756
757
758
759
760
761
762
763
764
765
766
767
768
769
760
761
762
763
764
765
766
767
768
769
770
771
772
773
774
775
776
777
778
779
770
771
772
773
774
775
776
777
778
779
780
781
782
783
784
785
786
787
788
789
780
781
782
783
784
785
786
787
788
789
790
791
792
793
794
795
796
797
798
799
790
791
792
793
794
795
796
797
798
799
800
801
802
803
804
805
806
807
808
809
800
801
802
803
804
805
806
807
808
809
810
811
812
813
814
815
816
817
818
819
810
811
812
813
814
815
816
817
818
819
820
821
822
823
824
825
826
827
828
829
820
821
822
823
824
825
826
827
828
829
830
831
832
833
834
835
836
837
838
839
830
831
832
833
834
835
836
837
838
839
840
841
842
843
844
845
846
847
848
849
840
841
842
843
844
845
846
847
848
849
850
851
852
853
854
855
856
857
858
859
850
851
852
853
854
855
856
857
858
859
860
861
862
863
864
865
866
867
868
869
860
861
862
863
864
865
866
867
868
869
870
871
872
873
874
875
876
877
878
879
870
871
872
873
874
875
876
877
878
879
880
881
882
883
884
885
886
887
888
889
880
881
882
883
884
885
886
887
888
889
890
891
892
893
894
895
896
897
898
899
890
891
892
893
894
895
896
897
898
899
900
901
902
903
904
905
906
907
908
909
900
901
902
903
904
905
906
907
908
909
910
911
912
913
914
915
916
917
918
919
910
911
912
913
914
915
916
917
918
919
920
921
922
923
924
925
926
927
928
929
920
921
922
923
924
925
926
927
928
929
930
931
932
933
934
935
936
937
938
939
930
931
932
933
934
935
936
937
938
939
940
941
942
943
944
945
946
947
948
949
940
941
942
943
944
945
946
947
948
949
950
951
952
953
954
955
956
957
958
959
950
951
952
953
954
955
956
957
958
959
960
961
962
963
964
965
966
967
968
969
960
961
962
963
964
965
966
967
968
969
970
971
972
973
974
975
976
977
978
979
970
971
972
973
974
975
976
977
978
979
980
981
982
983
984
985
986
987
988
989
980
981
982
983
984
985
986
987
988
989
990
991
992
993
994
995
996
997
998
999
990
991
992
993
994
995
996
997
998
999
1000

Structure not only in similar bones in the same individual species, but also in animals in whom the bones, in their external characters corresponds; so that the general remarks in this paper are equally applicable to Comparative anatomy; so far at least as my observations have extended.

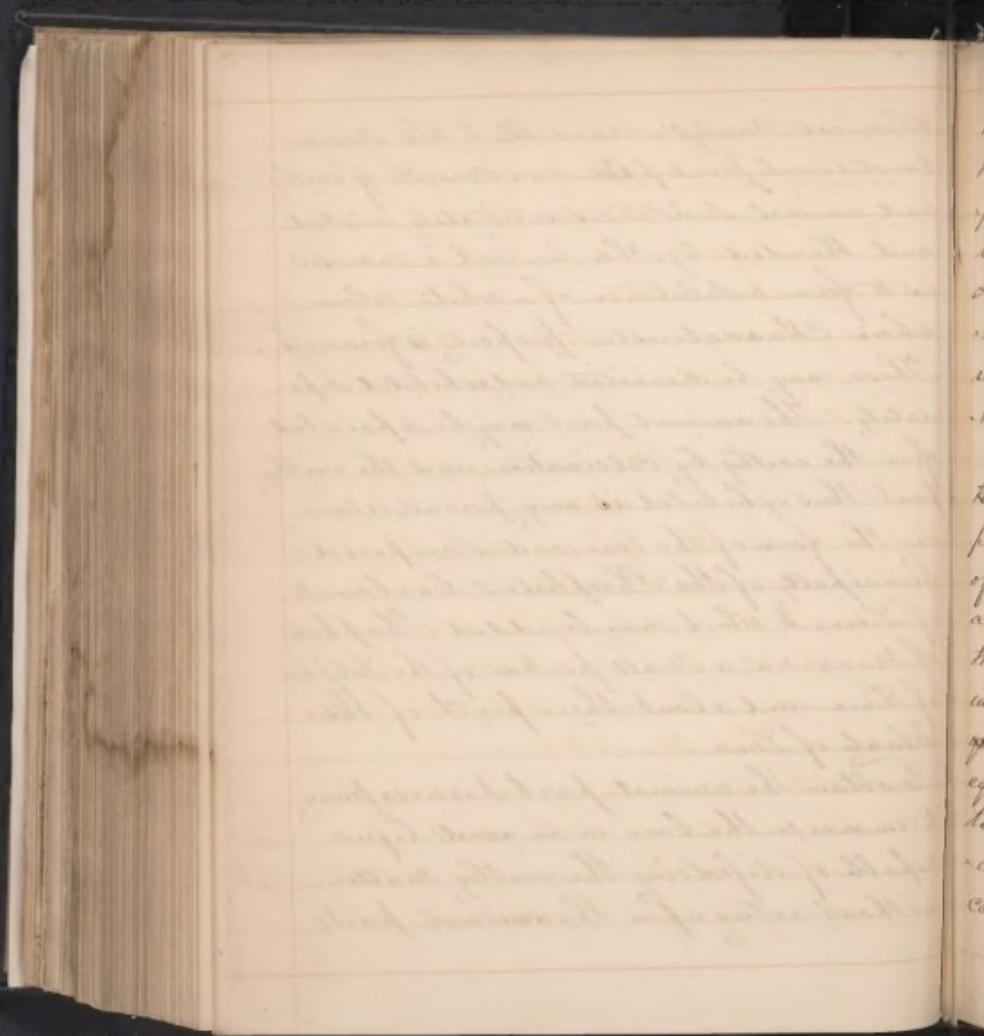
As introductory to the subject it may be proper to investigate the facts afforded us by Chemical analysis, as it will facilitate the elucidation of many facts connected with the formation and growth of bone; and also the changes incident to many morbid affections, together with the practical inferences drawn from these facts.

Although the bones entering into the composition of the skeleton of R.
it innumerable varieties in their structure, form and position; they are upon



Chemical Analysis reducible to the same constituent principles and consists of earthy and animal substances intimately mixed and blended together, in such a manner as to form a substance of a white colour, whose characteristic property is fireness. These may be disunited and exhibited separately. The animal part may be separated from the earthy by Calcination, and the earthy part thus exhibited is very porous, retaining the form of the bone, and is composed principally of the Phosphate & Carbonate of Lime; to which may be added Phosphate of Magnesia, a small portion of the Sulphate of Lime and about three per cent. of the Fluat of Lime.

To obtain the animal part it is necessary to immerse the bone in an acid liquor capable of dissolving the earthy matter, without acting upon the animal part;



The Muriatic acid is generally used for this purpose, and is possessed of the property of dissolving the earthy salts, together with the gelatin, and the soft elastic substance that remained undissolved, retaining the original shape of the bone, resembles in its Chemical properties coagulated albumen.

The relative proportion that the earthy salts bear to the animal part is materially influenced by the age of the individual; it likewise varies according to the nature of the bone, and the purposes which it is destined to serve in the animal economy. At puberty, the quantity of these two substances are nearly equal in the generality of bones. In the teeth the quantity of earthy matter predominates, and the enamel is wholly composed of the earthy substance, which

is rendered necessary from its painful situation.
In some diseases the earthy salts are dissolved
into the system, and the cartilaginous band
is diminished: when this occurs in infancy,
a disease is produced termed Rachitis; a
similar complaint occurring in advanced life,
is designated by the term Mollities. Hence
the knowledge of the chemical history of
bone, as stated on a former occasion, is very
useful in tracing the formation and growth
of bone, as also the changes produced by cer-
tain morbid affections; but whether it is
calculated to facilitate in any considerable
degree our practical knowledge is exceed-
ingly problematical. Although this affection
is generally admitted at the present day,
there was a period when dabblers who
whistled in the diseases noticed above,
which in their chemical properties corresponded
with the earthy salts of bones, with a suspicion

2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60
61
62
63
64
65
66
67
68
69
70
71
72
73
74
75
76
77
78
79
80
81
82
83
84
85
86
87
88
89
90
91
92
93
94
95
96
97
98
99
100

that they would be carried by the blood-vessels
and deposited in the parts where this deficiency
existed. These erroneous opinions, which
were sanctioned by the highest authorities,
prevailed a practice equally absurd and
injudicious, and which it was happily ex-
ploded.

Thus constructed the bones consist of
the soft parts compose a skeleton, and are
separated from their function to give
stability to the system, and afford a firm
basis for the body. I speak, many impor-
tant parts, as the brain, the contents of the
Thorax, etc. from the injuries existing from
the action of external forces. Still they afford
attachment to muscles exerted from Levers,
which are set in motion by muscular con-
traction, and in this manner locomotion
is effected, or in addition to this, it gives
symmetry and elegance to the body. The

卷之三

1.

size of which is regulated by this system.
Having noticed the facts afforded by chemical analysis, we shall proceed to shew that the bones are like the soft parts possessed of blood-vessels, nerves and lymphatic vessels. The existence of blood vessels are proved directly and indirectly. If for instance an animal be nourished with food mixed with madder, the bones will assume a red colour, which is evidently derived from this substance. They are also proved directly by injecting the bone - These vessels are transmitted to the bone by a membrane which covers its external surface, denominated periosteum, which will be more particularly noticed hereafter. The bones also receive vessels by foramina which penetrate the substance of the bone - In a natural state the bones possess but little sensibility, but when inflamed they

are very doubtful which proves the presence of
nerves.

The existence of about one part ^{is} equally
common with the blood vessels, although they
cannot be demonstrated except by their effects
but these are too obvious to admit of doubt.

The bones constructed in this manner, are
possessed of an innate power of repairing an-
guished occasions, and in some instances
this power of separation is exerted in a
surprising degree; as is strikingly exemplified
in Necrosis, a disease which is similar to
mortification of the soft parts of the body, in
where the *Sequestra* is thrown off and a
reproduction of bone is effected.

This is said to be analogous to the mortifica-
tion of the soft parts of the body, but it differs
materially from it, for in Necrosis the peri-
osteum, which is supposed to serve the same
office to bone as the integuments do for the



soft parts, separated and is the agent concerned in the reproduction of the bone; whereas in modification of the soft part, the arguments are removed, this shows the unpropriet of separating these two processes.

As the reproductive power of a part are proportioned to its vascularity, it is obvious that this power must be fully exerted in bone. This on this principle we explain the reason why a fractured bone requires daily, says, and not infrequently two or three months. When a fracture in the continuity of a soft part, if brought into apposition, heals in two or three days; — (See Moyse on the Bone) —

The vascularity of bone varies according to the age of the individual, in infancy it is greatest and consequently its vital energies are most considerable at this period, as the animal increases in years this power

gradually decreased.

The membranous covering of bone is denominated *Parietum*; its surface is considerately smooth, perceptible; it adheres firmly to the bone by the intervention of fibres, blood-vessels, lymphatic, &c. The *periosteum* covers all the external surface of bone, except those parts forming the articulations, the surfaces occupied by the insertion of tendons, ligaments, ~~and~~ the body of the teeth and internal surface of the cranium. The functions of the periosteum are performed on the external surface of the cranium by the *Aura Mater*. The external surface of the cranium is supplied with a membrane similar in every respect to the periosteum denominated *Pia mater*.

The *periosteum* serves a threefold purpose in the animal economy. It affords

100

200

300

400

500

600

700

800

900

1000

1100

1200

1300

1400

1500

1600

1700

1800

1900

2000

2100

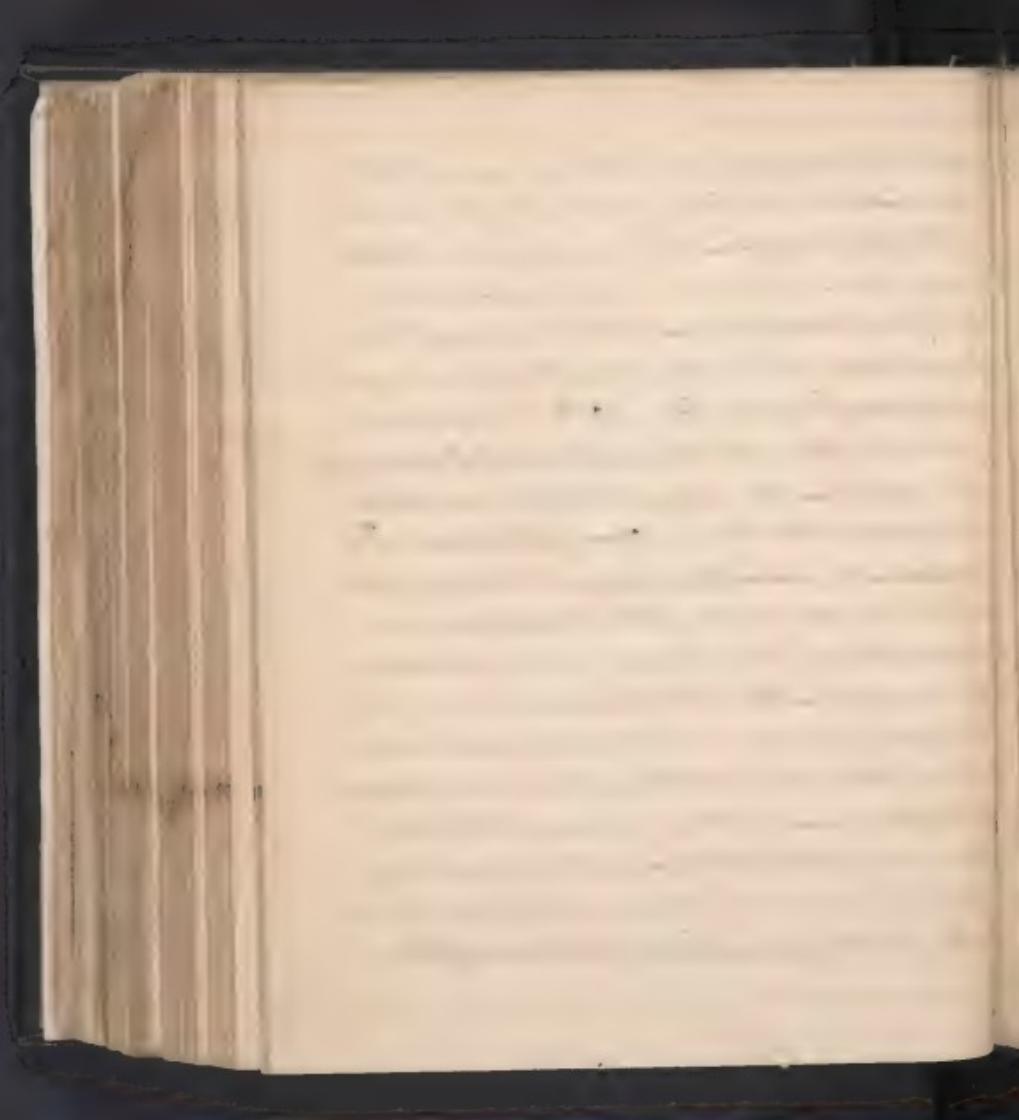
2200

2300

2400

2500

into blood vessels etc. to the bone. 2⁴⁴. It
circumscribes the bone, preventing the disease
of the soft part from being propagated to the
bone, hence when an abscess forms in the
soft part, contiguous to the surface of the
periosteum, it thickens and the diseas. is
excluded from the bone. 3⁴⁴ It is rendered
probable from the observations of Boyce and
other writers on the subject that the periosteum
reproduces the bone in cases of necrosis. This
is rendered probable by a fact that in parts
which are destitute of the membrane are
production of bone does not take place; as
for example in the teeth; when a portion of the
enamel is removed in the adult a reproduc-
tion of bone does not take place in consequence
of the periodontium being removed with the
tooth; it is probable from this circumstance
that the functions of the linea dentis are limited
in this particular. The importance of the

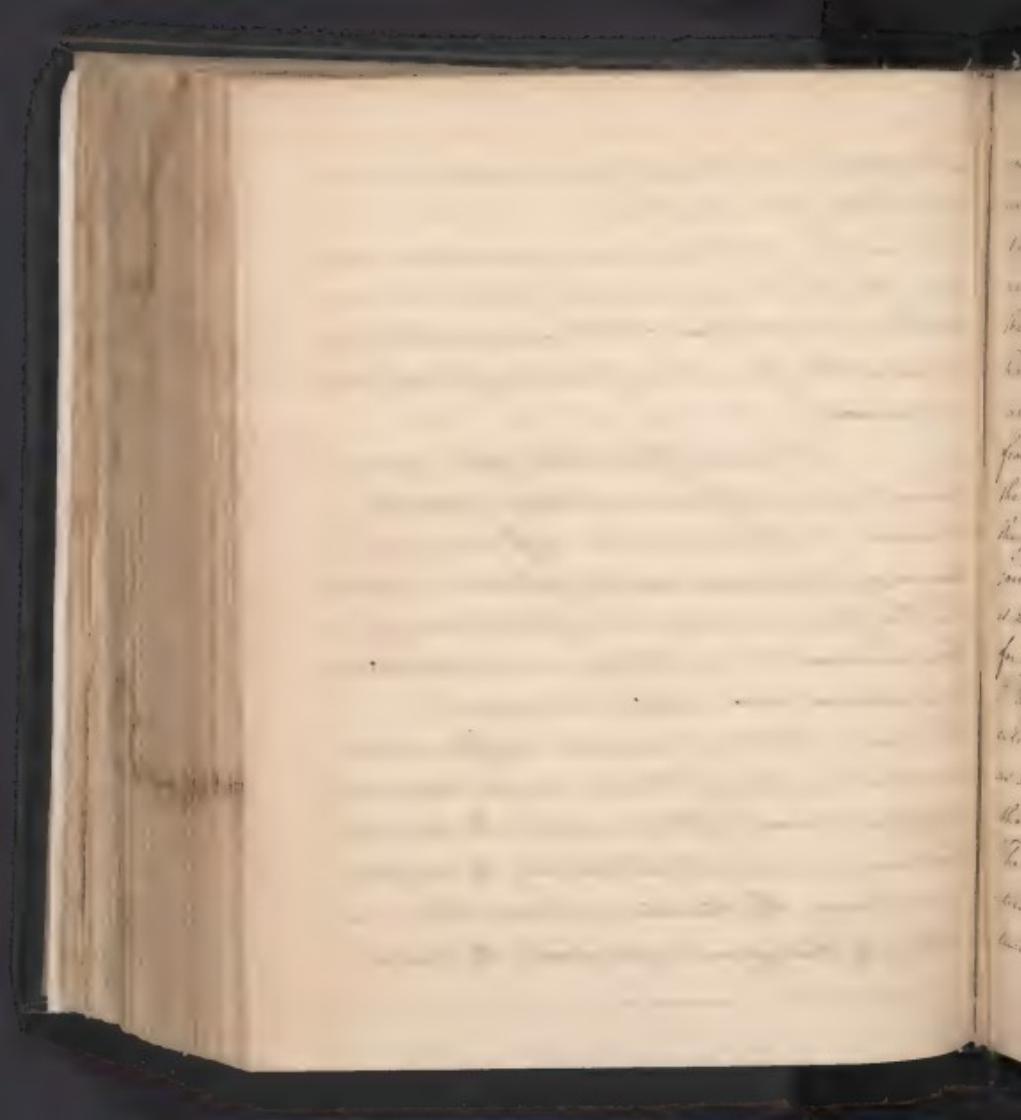


periosteum is constantly respirable, as it ex-
ists at every period of life.

Bones have a fibrous and laminated struc-
ture. The former is proved by calcination and
is obvious in the bones of the head, and the long
bones, as the femur and tibia may be separated
into laminae.

Bones differ in their form, and a
corresponding difference is observable in their
structure. For the convenience of description
they may be divided into the cylindrical & flat.
The flat bones are composed of two plates of fine
bone, between which a spongy or reticular substance
is interposed, technically termed spongia.

The degree of solidity varies in different bones
and this diversity of structure is also observable
in different parts of the same bone. The variations,
however, are reducible to two, viz. the compact
and spongy. The structure of some bones are
uniformly spongy as carpal bones, the tarsus,



10

vertebrae, Marrow, &c. In the long bones,
at the femur and tibia, the spongy substance
is confined to the extremities which
are longer than the middle portion where
the particles of bone are more solid and firm,
having a cavity in the centre, in which is situated
the marrow. Several advantages result
from this arrangement. 1st By being larger at
the extremities the opposing surfaces forming
the joint are more extensive by which the
joints are rendered stronger. This enlargement
is not attended with an augmentation of weight
for it has been ascertained by professor
Physick that an inch of bone taken from the
extremity of the femur had the same weight
as an inch taken from the middle portion al-
though the former occupies the greater bulk.
The bones are less liable to fracture near the extremi-
ties, this is not the least important use, for frac-
tures are stated to be dangerous in proportion

he
the
seen
It
can
have
the
you
-er
the
in
the
the
The
-er
not
the
was
to
the

to its vicinity to the joint. It is stated that towards the middle the Membrane is more firm having a central cavity in which the marrow is situated.

This central cavity renders the bone much stronger.

It is a principle in Mechanics that hollow cylinders

are stronger than those that are solid, and on

this account the bones are not only stronger but

are lighter by this arrangement. The marrow

that is contained in the canals of bones is of an

unctuous nature, and in herbaceous animals, it is

said to harden when it becomes cold: but it re-

mains fluid in carnivorous animals. In young

Subjects it is more fluid, and is composed of a red colour.

The marrow is contained in cells and enclosed by

a thin bone called perosteum internum. This

and what has been applied to the marrow, have

it is supposed it was to prevent the bone

becoming brittle; others suppose it was used

to fill up the void, and in that manner to prevent

the pressure of the atmosphere from crushing

the

210

Mr.

b

o

ft

th

stu

in

Re

an

g

th

fa

th

the

112

by

as

their paroxysms. See first Cyclopaedia
et cetera. 2^d best observed "There is no
matter in the animal economy more ductile
to fill their spaces than the marrow, and it is
to be regarded as a part of the cellular system
of the animal. In corroboratio of this remark
it has been observed that in emaciated
and droptical subjects where there is no fat
in other parts, there is likewise none in the bone.
Why not then may it be useful in effect
as a change in the blood preparatory
to conversion into bone? In confirmation
of this we may state at great exactuality a
infinity in

The use of the Spongy Structure
to prevent the force of pernicious germs
being propagated to remote parts of the body.
This important fact was first suggested
by professor Physick, who had procured by
a very ingenious experiment

The
year
before
begin
in the
honey
season
to go
there
because
white
flies
in the
below
the
the
dear
was
there

The apparatus consists of a board,
from which five balls of solid bone are
suspended; three of the balls are connected
together, and the two exterior are in contact
with the others, but not connected with
them; upon one of the exterior balls, being
removed to a given distance, and allowed
to strike the others, the force is extended
through the three balls to the fourth, which
being unconnected, is forced to a distance
which is nearly equal to that which the
first ball was removed; but, when a
substance of a spongy nature is interposed
between the balls that are connected toge-
ther, and the experiment is repeated,
the force of the blow being expended in
the reticular substance, the exterior ball
retains nearly the same position that it
was in before the experiment.

The above experiment is intended particularly

to exemplify the effects of Blew upon the
Cervix, and to shew the power of the
tendon-like substance, in preventing the force
of blows from affecting the substance of
the brain. The above remarks are also
applicable to the Spagyn Substance exist-
ing in other parts of the skeleton.

For the above experiment and many of
the preceding observations, I acknowledge
myself indebted to professor Physick's
Lectures, whose important discoveries
have rendered this subject, that is
principally, ^{say} one of the most interesting
and interesting in this department of Med-
ical Science. My acknowledgement must also
be due to the professor in the Surgical
Institution, whose accurate, ^{and} well-considered
and spirited assertions will ever be
remembered with gratitude by the student
generally; permit me, Sir, as an individual

to 5

242

100
104

132

Recd
1/2
1864
H. A.

44

776

14

de

10

to asperf the many obligations we owe
to you, and most assured that we shall
be ever. simulans in meeting your
regard in

I shall now proceed to make a
few general remarks on the formation of
Bones. This is a subject peculiarly interest-
ing, not shewing the powers of the animal
economy in a very striking light. In this pro-
cess we observe the blood, a homogeneous
fluid, gradually assimilated into a substance
that is stability and firmness; second,
we see other parts of the system. If we except
the flat bones and the teeth, most others
are formed in cartilage. The first change
observable is an enlargement in the capsule
of the part, after which the earthly matter
is deposited, as ossification progresses the
bone gradually assumes the shape of the
cartilage in which it was originally formed;

The
of
show
the
the
of the
then
habit
the
The f
Ente
the
the
see
the
is the
the
such
and
one

The deposition of
the cartilage, that affords a nucleus for the
osseous matter is gradually removed by the
absorbing vessels. In flat bones the osseous mat-
ter is deposited like two plates, one above
the other, that gradually extend and unite
at their edges, leaving a space between
them, which is occupied by the reticular
substance. In each plate there are one
or more centres of ossification, from which
the fibres extend like radii from the
centre. The time requisite for effecting
this change varies in different bones, some
as the for example the small bones of the ear
are completely formed at birth; in others
the process of ossification is very rapid
as the clavicle, teeth &c. The generality of
bones are not completely formed, until
puberty at which period the ejection
and absorption being equal, counterbal-
ance each other and remain in equilibrium.

has
had a
will be
place
self &
which
body to

Having concluded my observations on
this Subject, it is with diffidence I sub-
mit them to your examination, and lay
claim to a distinction, which I flatter my-
self I am not wholly undeserving of, and
which is the privilege of your honorable
body to confer.

Ina

Antio

a